SYSTEMATIC AND RANDOM ERROR REVISITED

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The American National Standards Institute (ANSI) defines systematic error as "An error which remains constant over replicate measurements." It would seem from the ANSI definition that a systematic error is not really an error at all; it is merely a failure to calibrate the measurement system properly because if the error is constant why not simply correct for it? Yet systematic errors unquestionably exist, and they differ in some fundamental way from the kind of errors that we call "random." Early papers by Eisenhart and by Youden discussed systematic versus random error with regard to measurements in the physical sciences, but not in a fundamental way, and the distinction remains clouded by controversy. The lack of a general agreement on definitions has led to a plethora of different and often confusing methods on how to quantify the total uncertainty of a measurement that incorporates both its systematic and random errors. Some assert that systematic error should be treated by non-statistical methods. We disagree with this approach, and we provide basic definitions based on entropy concepts, and a statistical methodology for combining errors and making statements of total measurement uncertainty. We illustrate our methods with radiometric assay data.

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